Hydrogeologic Investigation of the Detrital, Hualapai, and Sacramento Valleys of Northwestern Arizona: *A Project of the Rural Watershed Initiative*

USGS science for a changing world

ADWR ARIZONA DEPARTMENT OF WATER RESOURCES

INTRODUCTION

The Detrital, Hualapai, and Sacramento Valleys are broad, intermountain desert basins in Mohave County, northwestern Arizona, and are home to residents in the city of Kingman and several rural communities (fig. 1). Ground water is the primary source of water in these valleys and is essential for many economic and cultural activities. As in many parts of the Western United States, population growth in these valleys is substantial. From 2000 to 2004, the population of Kingman grew from 20,100 to 24,600—an increase of 22 percent (Arizona Department of Economic Security, 2005). During the same time period, the population of Mohave County increased by 16 percent. Management of the available ground-water resources in these valleys guided by a comprehensive scientific understanding can help the growing communities to meet their needs in a sustainable manner.

In 2005, the U.S. Geological Survey (USGS) began an investigation of the hydrogeology of the Detrital, Hualapai, and Sacramento Valleys in cooperation with the Arizona Department of Water Resources (ADWR) as part of the Rural Watershed Initiative (RWI), a program established by the State of Arizona and managed by the ADWR.

The primary objective of this investigation is to improve the understanding of the hydrogeologic systems of Detrital, Hualapai, and Sacramento Valleys. This will be accomplished by:

1. Assessing the current knowledge of the ground-water flow system and existing data-collection networks, and identifying additional data needs.
2. Improving the understanding of the extent and lithology of geologic units and structures, and their relation to the storage and movement of ground water.
3. Improving the understanding of ground-water movement and the estimates for ground-water budget terms, including recharge, discharge, and total water in storage.
4. Evaluating the ground-water quality for key water uses.
5. Establishing a hydrologic-monitoring network to detect and characterize changes in aquifer conditions.
6. Informing the hydrologic community and valley residents about hydrologic conditions.

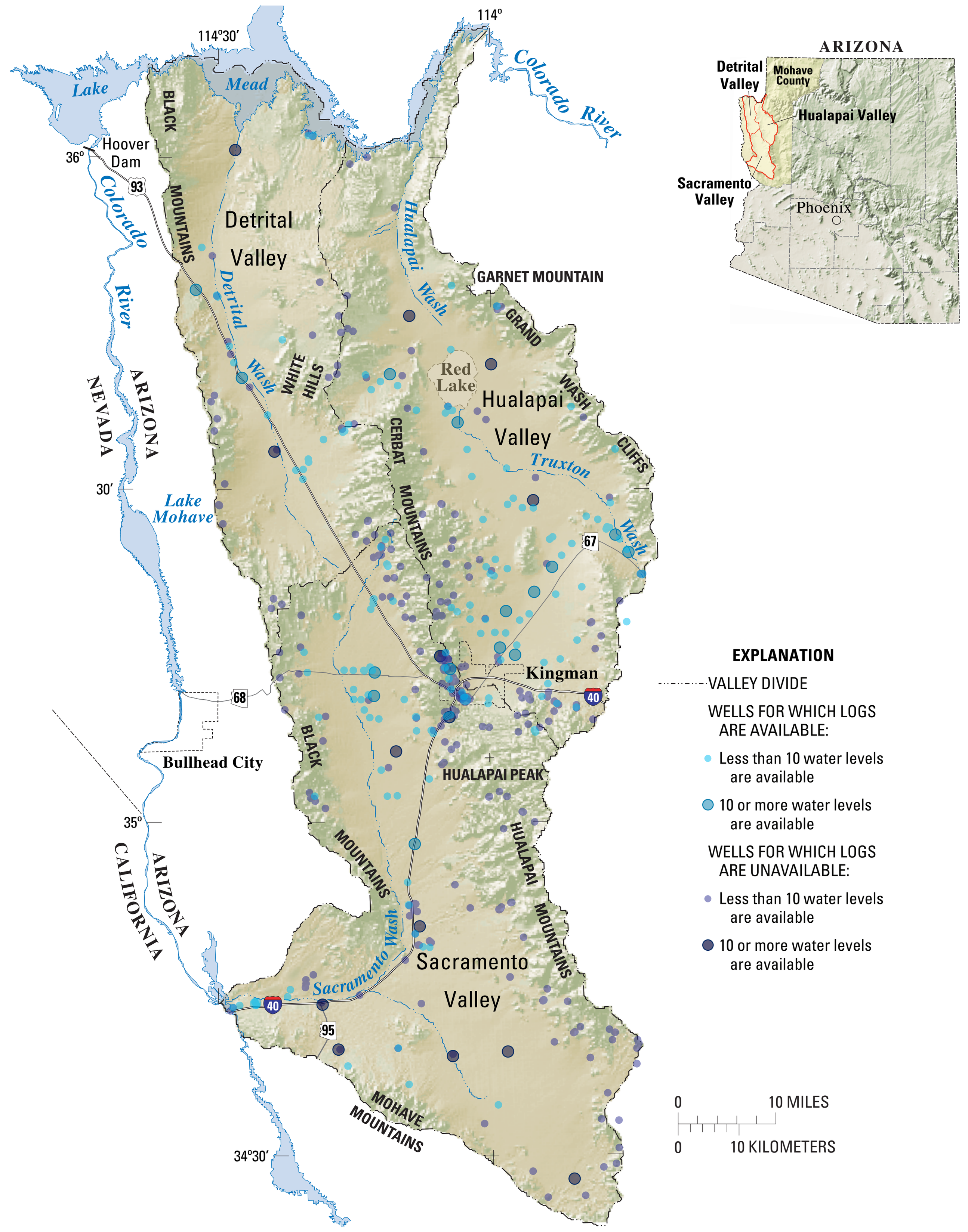

Figure 1. Physiography and location of water-level and well-log data for Detrital, Hualapai, and Sacramento Valleys, northwestern Arizona.

HYDROLOGY AND WATER USE

Detrital Wash, Hualapai Wash, and Sacramento Wash are the primary streams in their valleys and drain to the Colorado River (fig. 1). Streams generally flow only in response to regionally extensive winter storms or from spatially scattered summer thunderstorms. Runoff in mountain tributaries usually does not reach the valley's primary stream, but rather infiltrates the streambed sediments or evaporates.

Ground water from the basin-fill aquifer is the primary water supply for each of the three valleys. The older basin fill is the primary water-bearing deposit because intermediate and younger basin fill are above the water table in most areas. Most ground-water withdrawals in the valleys are for municipal and industrial uses; a small percentage of withdrawals is used for agriculture. Regional ground-water movement in the basin-fill aquifer generally is from the mountain fronts towards the valley center and then along the valley axis to the Colorado River. In general, depths to ground water are greatest in the upper parts of the valleys and decrease downgradient to within a few feet below the land surface near the Colorado River.

PHYSICAL SETTING

The Detrital, Hualapai, and Sacramento Valleys are three distinct northwest-southeast trending alluvial basins in the Basin and Range Physiographic Province. The valley floors of Detrital and Hualapai Valleys generally slope downward to the north, and the valley floor of Sacramento Valley generally slopes downward to the south. Valley floor elevations range from about 3,500 feet near Kingman to about 500 feet at the mouth of Sacramento Wash. Mountain crests rise as much as 5,500 feet above valley floors, and the highest mountain in the study area is Hualapai Peak at 8,417 feet.

The climate of the valleys is arid to semiarid with hot summers and mild winters. Maximum daily temperatures in the valley floors typically are between 90 and 110ºF during the summer, and between 50 and 70ºF during the winter (Western Regional Climate Center, 2005). Annual precipitation on the valley floors ranges from about 5 to 10 inches. Valley floors generally are covered with sparse desert vegetation owing to the hot temperatures and little precipitation. Shrubs and trees cover mountain slopes and peaks in the higher elevations where temperatures are cooler and precipitation is greater. Annual precipitation in the mountains ranges from about 10 to 15 inches.

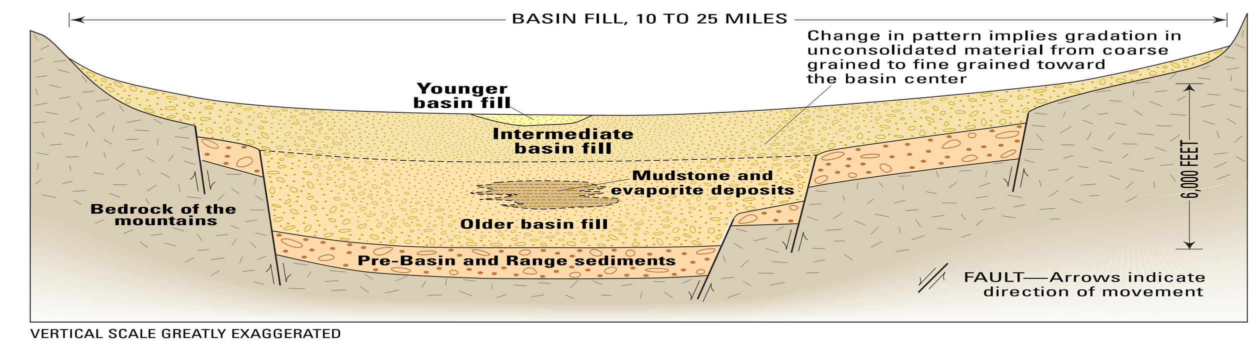

Figure 2. Generalized hydrogeologic section of the Detrital, Hualapai, and Sacramento Valleys (modified from Anderson and others, 1992).

GEOLOGY

The structural basins of Detrital, Hualapai, and Sacramento Valleys were formed during the Basin and Range disturbance, in which mountain ranges and basins were formed on adjacent sides of high-angle normal faults (fig. 2). The bedrock of the mountains that separate the valleys consists of granitic, metamorphic, sedimentary, and volcanic rocks (fig. 3). In most areas, the bedrock is relatively impermeable compared to the basin fill and forms barriers to ground-water movement in the basin-fill aquifer. Basin fill (fig. 2) ranges in thickness from a veneer along the mountain fronts to more than 5,000 ft in parts of each valley (Freethey and others, 1986; fig. 3). The basin fill is divided into older, intermediate, and younger hydrogeologic units (Gillespie and Bentley, 1971).

Older basin fill
- stratigraphically the oldest and deepest deposit
- consists of moderately consolidated fragments of rocks eroded from the surrounding mountains in a silty-clay or sandy matrix
- grain size decreases from pebble- and boulder-size fragments in the fanglomerate near the mountains to coarse sand and interbedded clay and silt in the basin center
- massive evaporite deposits occur in the older basin fill in the northern parts of Hualapai and Detrital Valleys (Gillespie and Bentley, 1971; Laney, 1979; Freethey and others, 1986; fig. 3)
- thickness is a few thousand feet

Intermediate basin fill
- composition of the intermediate basin fill is similar to that of the older basin fill
- becomes finer grained towards the basin center
- thickness is a few hundred feet

Younger basin fill
- consists of Holocene piedmont, stream, and playa deposits
- thickness is less than that of the older basin fill

Mud cracks in Red Lake playa, Hualapai Valley

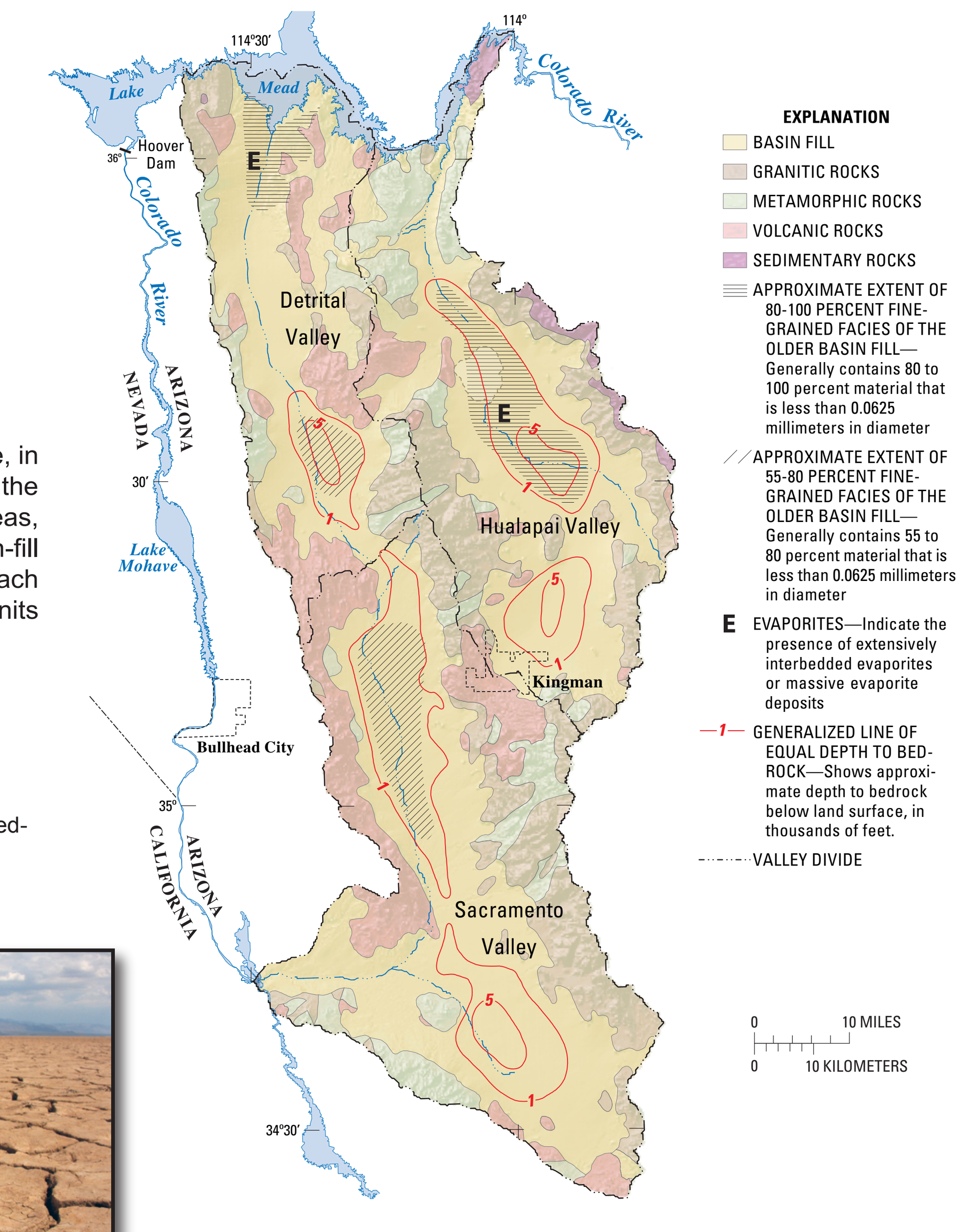

Figure 3. Bedrock geology and basin-fill characteristics in the Detrial, Hualapai, and Sacramento Valleys (modified from Richard and others, 2000, and Freethey and others, 1986).

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A U.S. Geological Fact-Sheet about this project can be found at:
http://pubs.usgs.gov/fs/2006/3008/

Additional information about the USGS Arizona Water Science Center can be found at:
http://az.water.usgs.gov

PLANNED APPROACH

The study will begin with a compilation of existing information to develop a hydrogeologic database for the three valleys. In addition, field surveys will be conducted to update existing data for boreholes, wells, and water levels (fig. 1). Information gained in these efforts will be used to refine the initial conceptual models of the hydrogeologic systems of the valleys and to guide data-collection efforts in the following years. Possible data-collection and analysis efforts include:

1. Geophysical and geological investigations to define geologic features that affect storage and flow of ground water. Features include structures, such as faults, and the thickness, lateral extent, and lithology of hydrogeologic units.
2. Determination of hydraulic properties of the hydrogeologic units using field and empirical methods.
3. Determination of ground-water storage and the direction and rate of ground-water movement using water-level, geometry, and hydraulic-property information for the hydrogeologic units.
4. Determination of ground-water recharge to and discharge from the basin-fill aquifers in each valley using information gained in item 3 about ground-water movement, as well as climate, water-use, and other data.
5. Establishment of a hydrologic-monitoring network that utilizes gravity data and water-level data to assess changes in ground-water storage over time.
6. Collection and analysis of ground-water samples from several wells to further characterize the extent of high dissolved-solids concentrations in ground water and their relation to hydrogeologic factors.

DATA COLLECTION

Setting up a total gravity station

Measuring gravity near Kingman

Gravity Data Collection—Gravity data will be used to help define depth to bedrock and to track temporal changes in storage

Signal transmitting wires

Signal receivers

Airplane used to collect GEOTEM data

Setting up the equipment for the TEM survey

Hauling and laying the cable for the TEM survey

Collecting TEM data

TEM Data Collection—Time-domain electromatic (TEM) data will be used to help define the subsurface extent of geologic formations

GEOTEM Data Collection—These TEM data are collected using airborne instrumentation.